

Idaho National Engineering and Environmental Laboratory

SCDAP/RELAP5-3D[©] - CONTAIN Linkage

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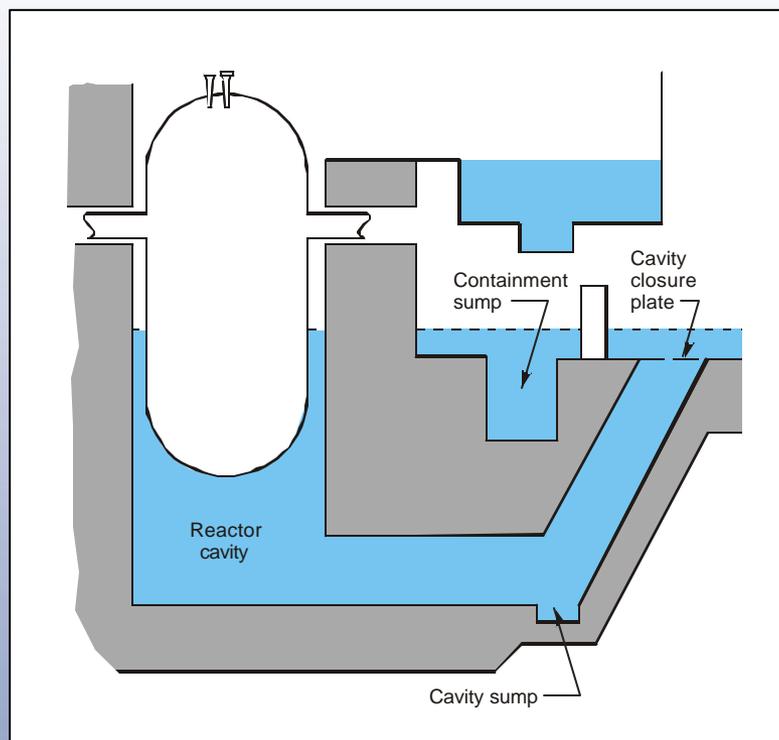
Objective and Outline

- **Objective**
 - *To discuss motivation and plans for linking SCDAP/RELAP5-3D[©] with CONTAIN 2.0*
- **Outline**
 - *Motivation for improved SCDAP/RELAP5-3D[©] - CONTAIN 2.0 linkage*
 - *Existing linkage using PVM and test case results*
 - *Proposed improved linkage*
 - *Summary*

References

- OECD/NEA Group of Experts, *SOAR on Containment Thermalhydraulics and Hydrogen Distribution*, NEA-CSNI-R-99-16, June 1999.
- SCDAP/RELAP5-3D[©] Code Development Team, *SCDAP/RELAP5-3D[©] CODE MANUALS, Volumes 1 through 5*, INEEL/EXT-02-00589, May 2002.
- Murata, K. K., et al., *Code Manual for CONTAIN 2.0: A Computer Code for Nuclear Reactor Containment Analysis*, NUREG/CR-6533, SAND97-1735, Sandia National Laboratories, December 1997.
- K. A. Smith, *Multi-Processor Based Simulation of Degraded Core and Containment Responses*, PhD Thesis, The Pennsylvania State University, December 1992.
- Gauntt, Randall, O., et al., *MELCOR Computer Code Manuals - User's Manual*, NUREG/CR-6119, Rev. 1, Sandia National Laboratories, October 1997.

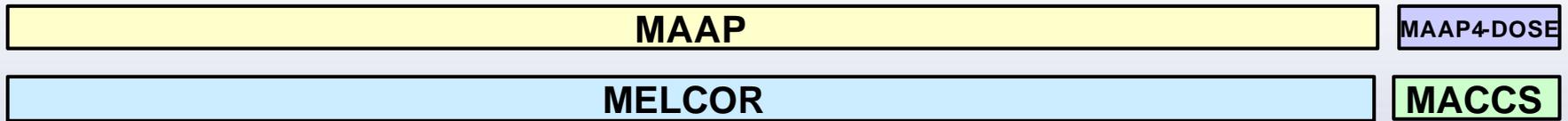
Linked mechanistic vessel/containment response analysis tool important for advanced reactors.



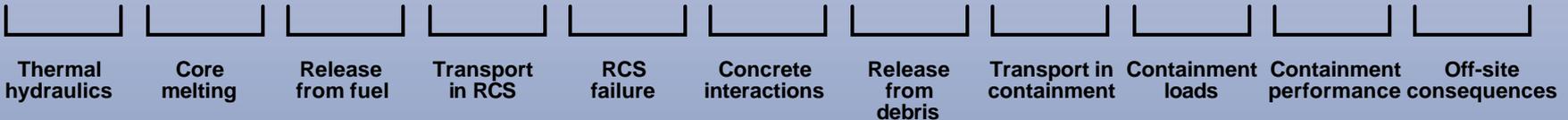
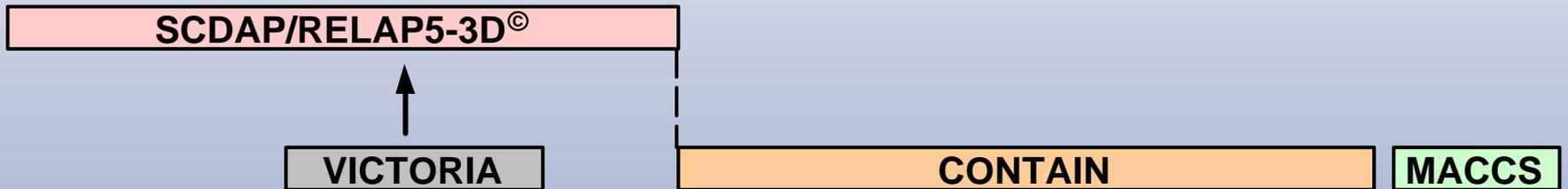
- *Increased dependence on passive systems*
 - ERVC
 - IRWST
 - PCCS
- *Requires analyses with increased fidelity in heat and mass transfer between RCS and containment*

SCDAP/RELAP5-3D[®] - CONTAIN linkage provides mechanistic tool for vessel/containment analysis.

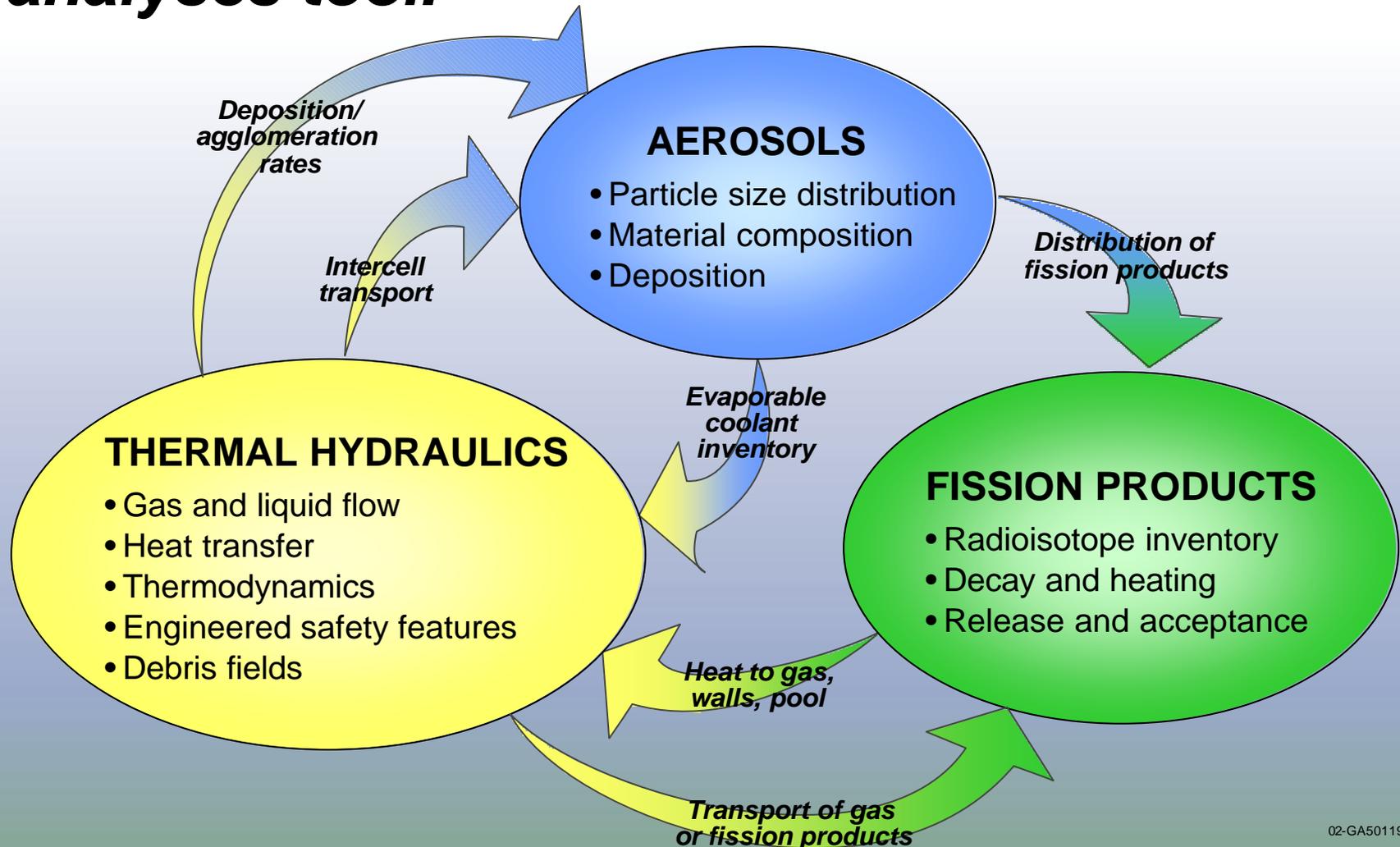
Integrated Codes



Detailed Mechanistic Codes



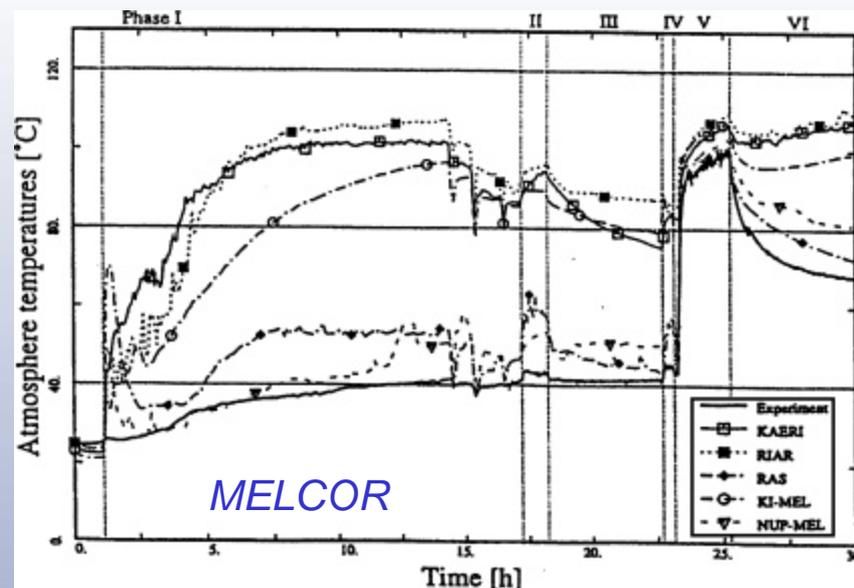
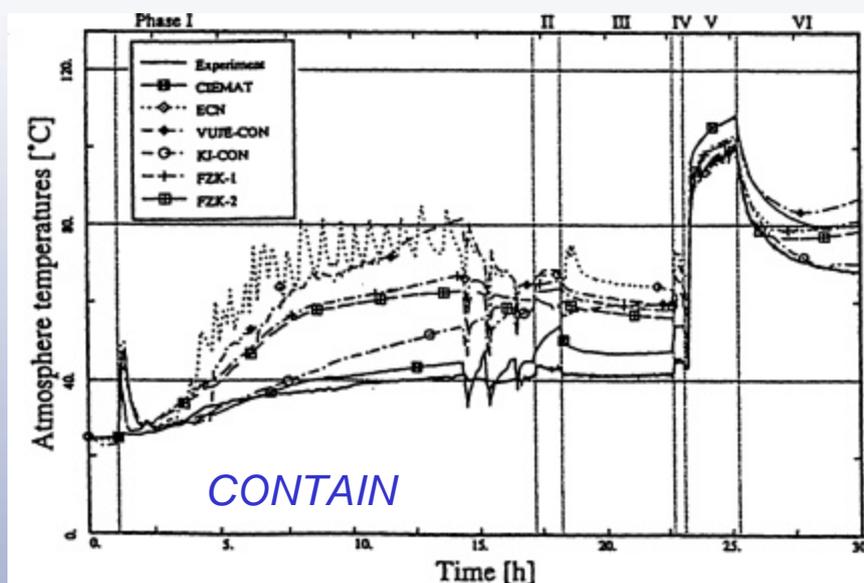
CONTAIN provides mechanistic containment analyses tool.



CONTAIN provides mechanistic containment analyses tool. (continued)

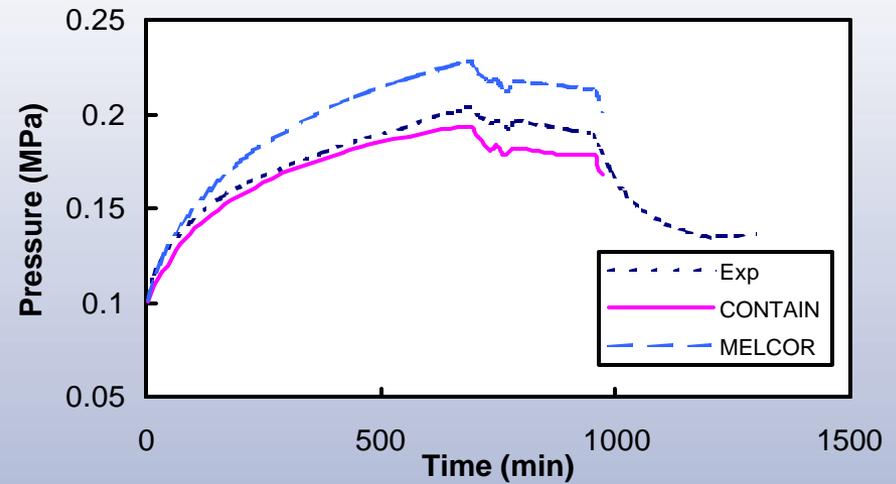
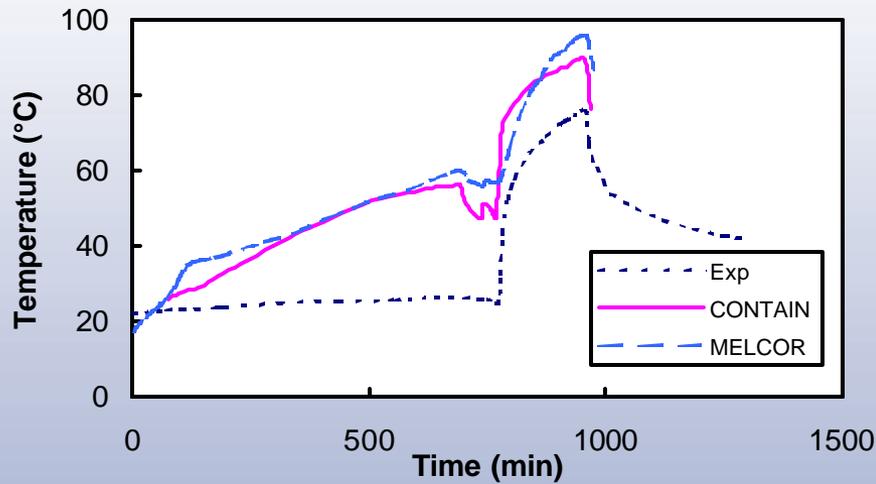
Code Function	CONTAIN	MELCOR
Transport of Direct Containment Heating (DCH) materials throughout the containment	Mechanistic models	Parametric models require user specified transportation
Radiation from corium to containment structures	Yes	No
Film flow modeling on structure walls	Yes	No
Coupling containment sprays with direct impingement on containment structures	No, but could be added	No
Flow solver	Advanced hybrid solver that automatically mitigates overmixing and allows stratification.	Flow path approach requiring judicious nodalization to prevent over-mixing
Local time-dependent velocities for calculating convection heat transfer coefficients	Flexible input allowed	Difficult to simulate
Inertial impact of aerosols	Yes	None
Variable solubility of aerosols	Yes	To be added in MELCOR 1.8.5

User modeling and input influence **CONTAIN** and **MELCOR** results.



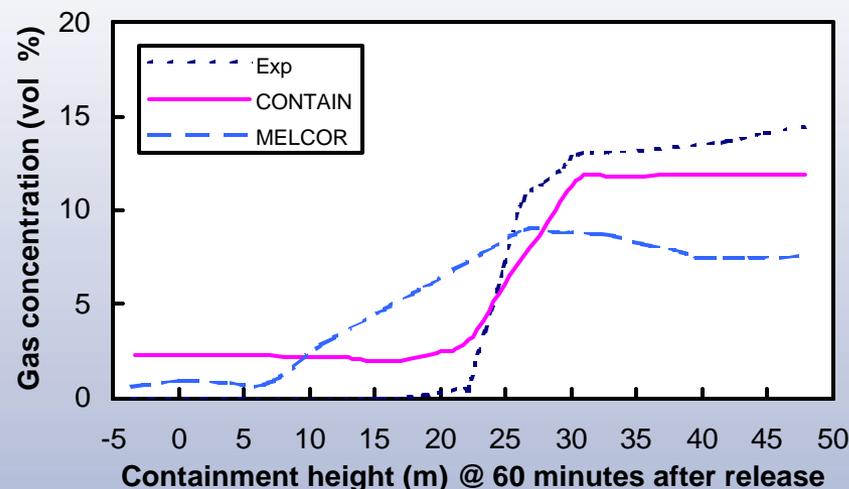
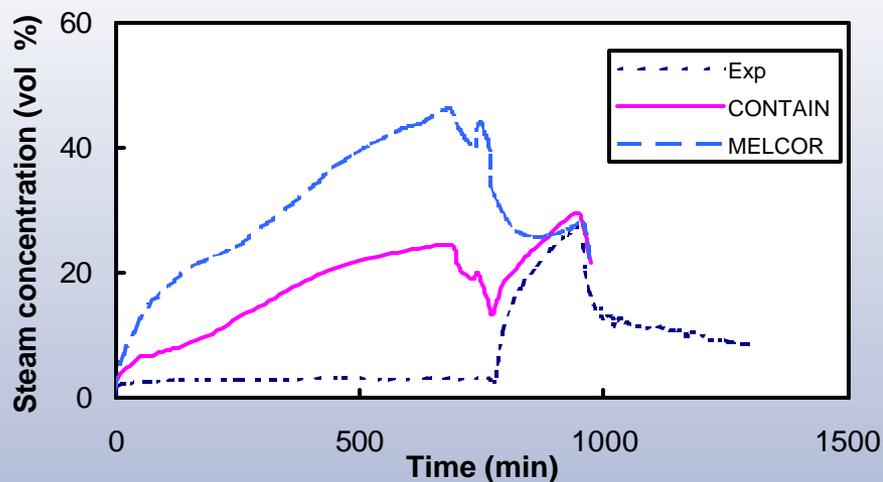
Wide range of MELCOR temperature predictions observed for BMC/VANAM M-3 (ISP 37)

CONTAIN results better matched HDR Test E11.2 data.



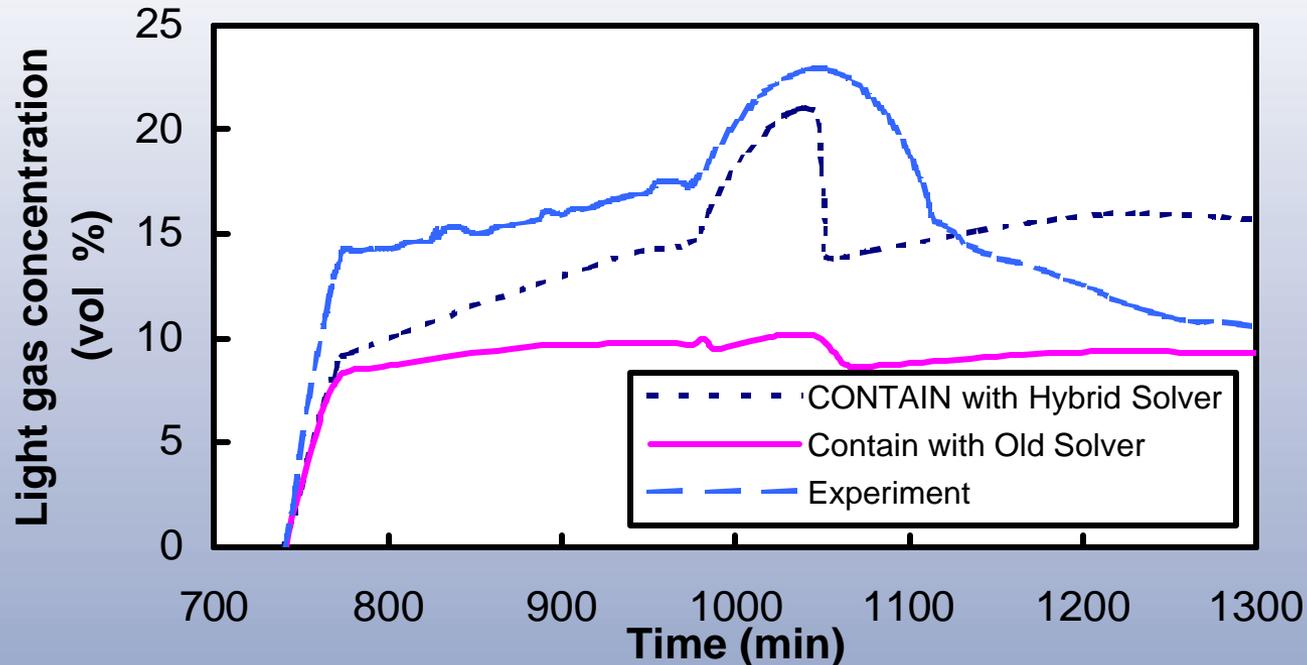
MELCOR and CONTAIN results calculated by AEA for ISP 29

CONTAIN results better matched HDR Test E11.2 data. (continued)



MELCOR and CONTAIN results calculated by AEA for ISP 29

CONTAIN with new hybrid flow solver better matches HDR Test E11.2 data.



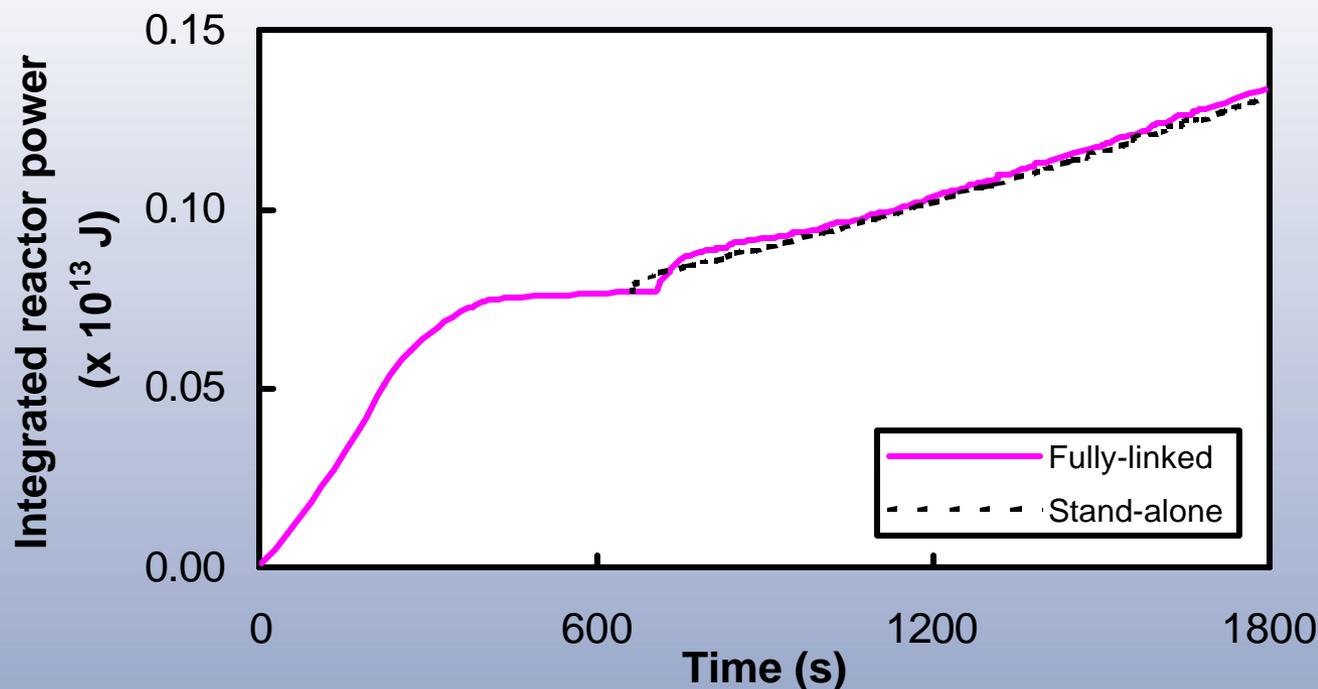
Initial SCDAP/RELAP5-CONTAIN PVM linkage completed by PSU.

- *Used PVM software to link SCDAP/RELAP5/MOD3.0 and CONTAIN 1.1.*
- *“Limited” linkage”:*
 - *Transfers break flowrates, SRV discharges, pool injection sources*
 - *Heat transfer from selected structures*
 - *Instantaneous flowrates, rather than integrated flowrates*
 - *Doesn't transfer non-condensable gases (hydrogen), fission products, aerosols, or discharged corium*
- *Demonstrated capabilities by analyzing Brown's Ferry ATWS*

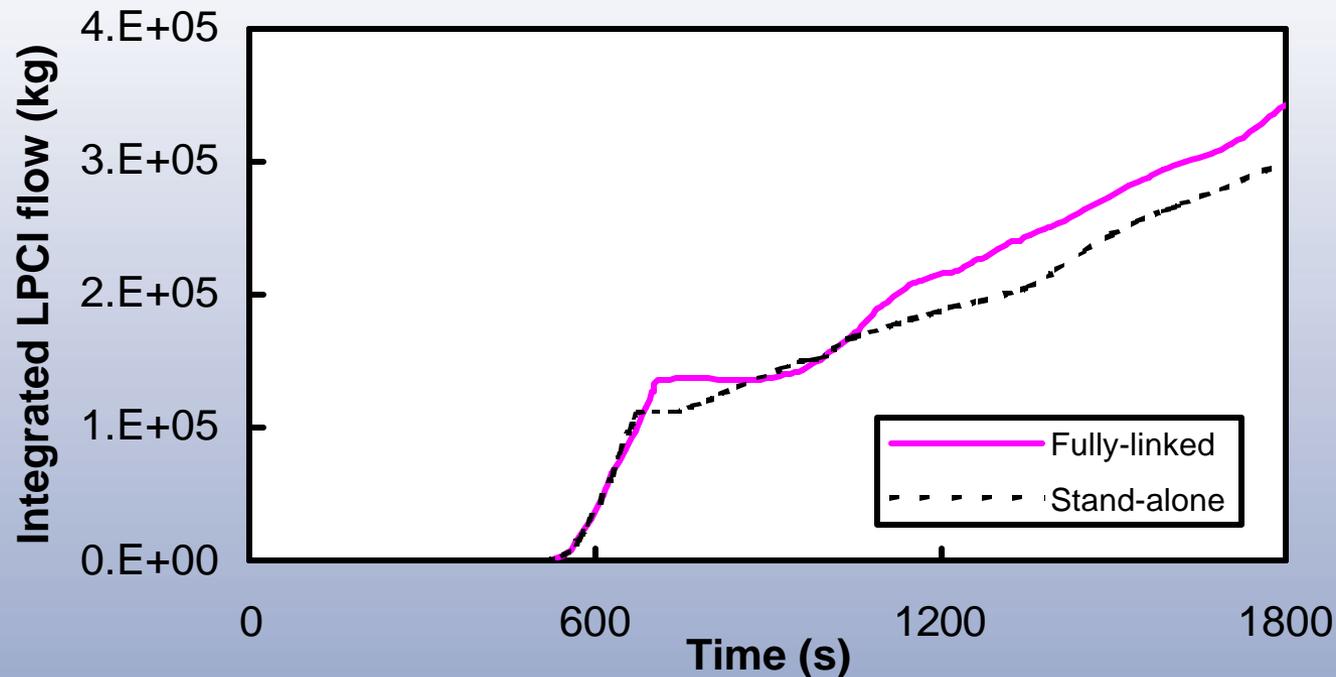
Calculation results illustrate feasibility and importance of linkage.

- *Fully linked*
 - *Coupled with PVM software*
- *Stand-alone*
 - *SCDAP/RELAP5 containment conditions taken from CONTAIN input deck and assumed to remain constant;*
 - *SCDAP/RELAP5 output entered as tabular data into CONTAIN*

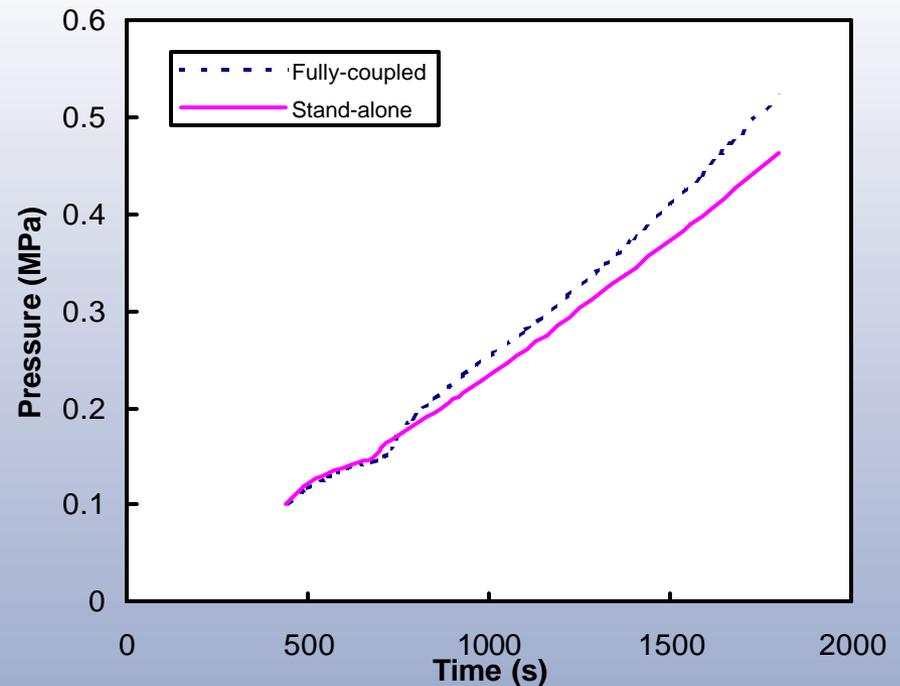
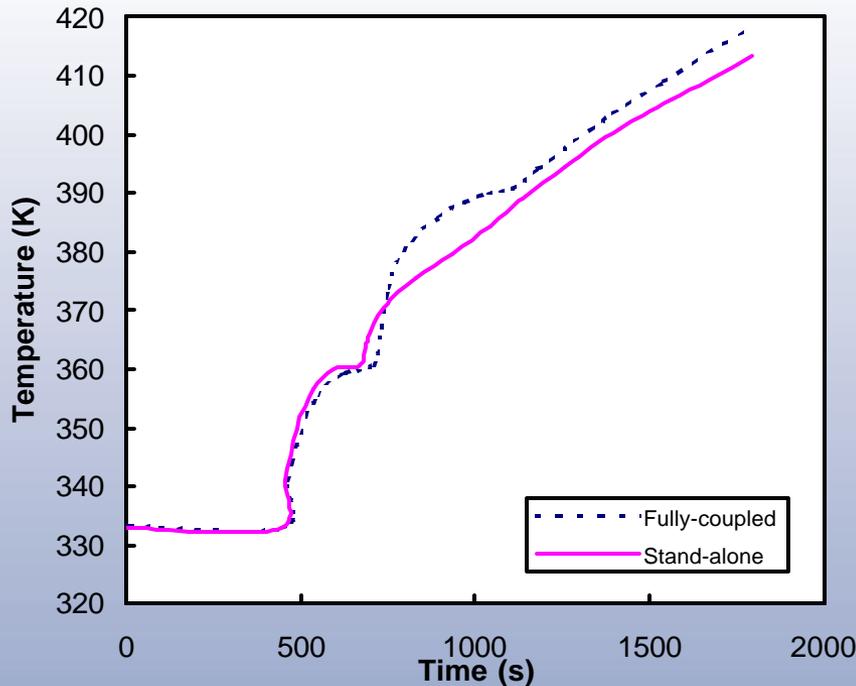
Similar reactor power results predicted by linked and stand-alone SCDAP/RELAP5.



Linked code predicts higher LPCI flow into RCS.



Linked code predicts higher containment temperatures and pressures.

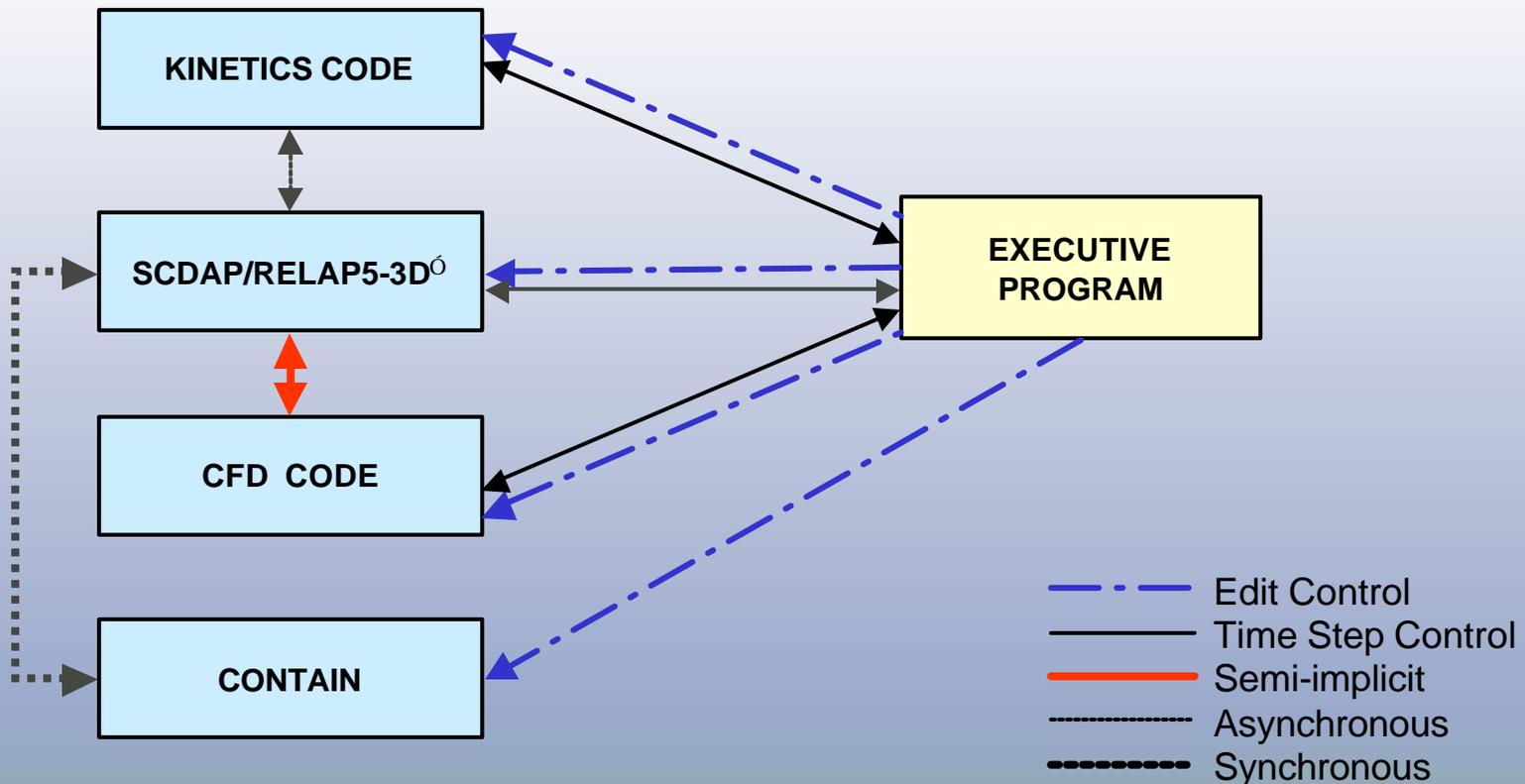


More defensible vessel/containment response achievable through fully-linked analysis.

Proposed PVM linkage will improve upon previous linkage efforts.

- *Integrate SCDAP/RELAP5-3D[©] and CONTAIN 2.0 codes using PVM software and Executive Program*
- *Use insights gained from previous linkage efforts:*
 - *Relative time for calculations to advance (and relative timestep)*
 - *Form of variables for data transfer (enthalpy and mass flowrate)*
 - *Subroutines selected for extracting and receiving data*
 - *Review previous coding and improve, as needed*
- *Compare advanced reactor plant analysis with and without integrated code*
 - *AP600 analysis performed for DVI “3BE” LOCA scenario*

Proposed PVM linkage will improve upon previous linkage efforts. (continued)



Summary

- *SCDAP/RELAP5-3D[©] and CONTAIN embody state-of-the-art thermal-hydraulic and severe accident models for mechanistic analyses*
- *SCDAP/RELAP5-3D[©] and CONTAIN results consistently serve as reference for comparison*
- *Proposed PVM linkage of SCDAP/RELAP5-3D[©] and CONTAIN 2.0 will provide a state-of-the-art mechanistic tool needed for coupled vessel / containment analyses*